BUREAU OF RECLAMATION

# Glen Canyon Dam
# Low-Head Hydropower Modifications

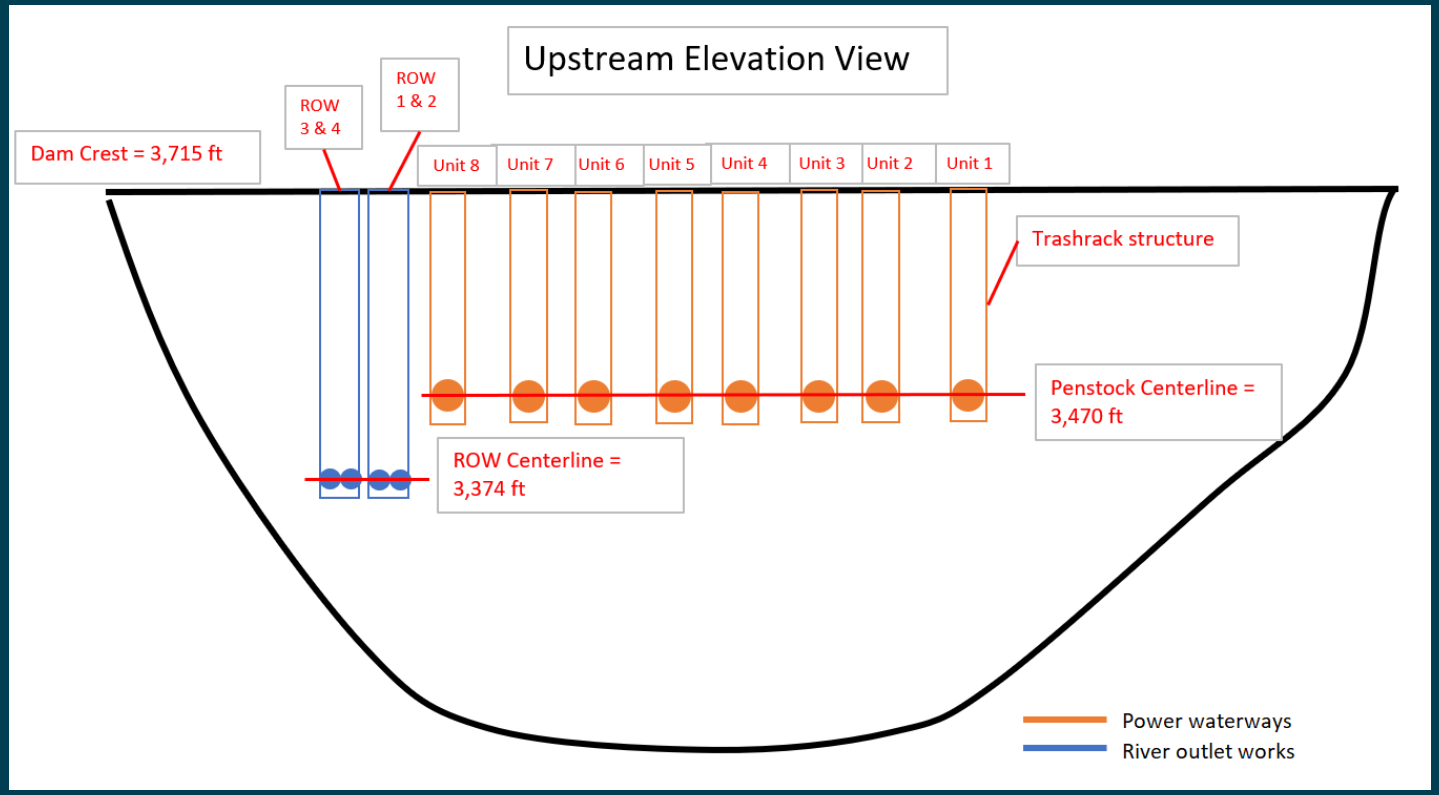
# Summary

- Background
- Purpose and Needs
- Alternatives
- Next Steps

# Background: Glen Canyon Dam and Powerplant


# Background: Glen Canyon Dam

- ROW centerline = 3,374′
  - 30′ above designer's estimated 100-year silt level
- Penstock centerline = 3,470′
  - 45′ above designer's estimated 150-year silt level
- Current silt level of forebay is ~3,200′



# Background: Value Analysis

- Reclamation's Value Program
- Systematic process of reviewing and analyzing the requirements and functions of…
  - Facilities
  - Projects
  - Systems
  - Etc.
- Value planning study
  - conducted at the conceptual stage
  - considers various alternatives to meet the identified needs
  - Alternative(s) selected for further analysis/study

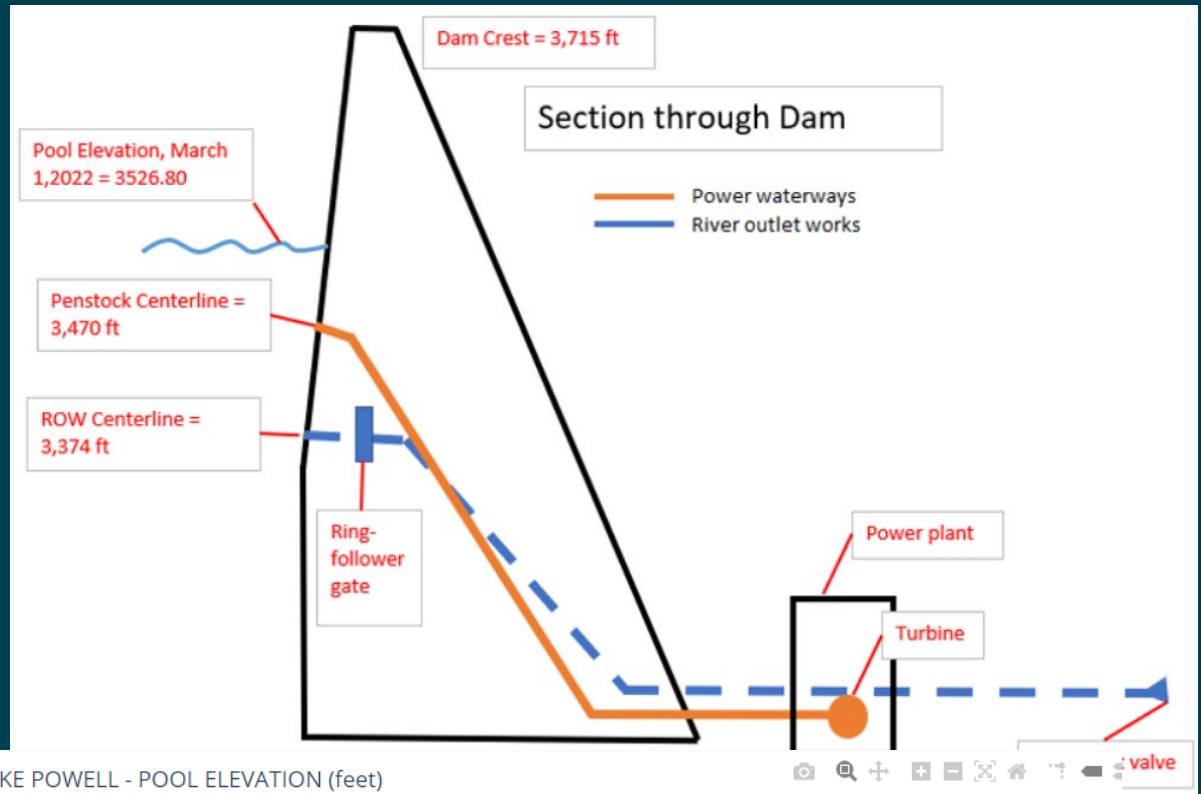
# Background: Glen Canyon Dam – Then vs Now

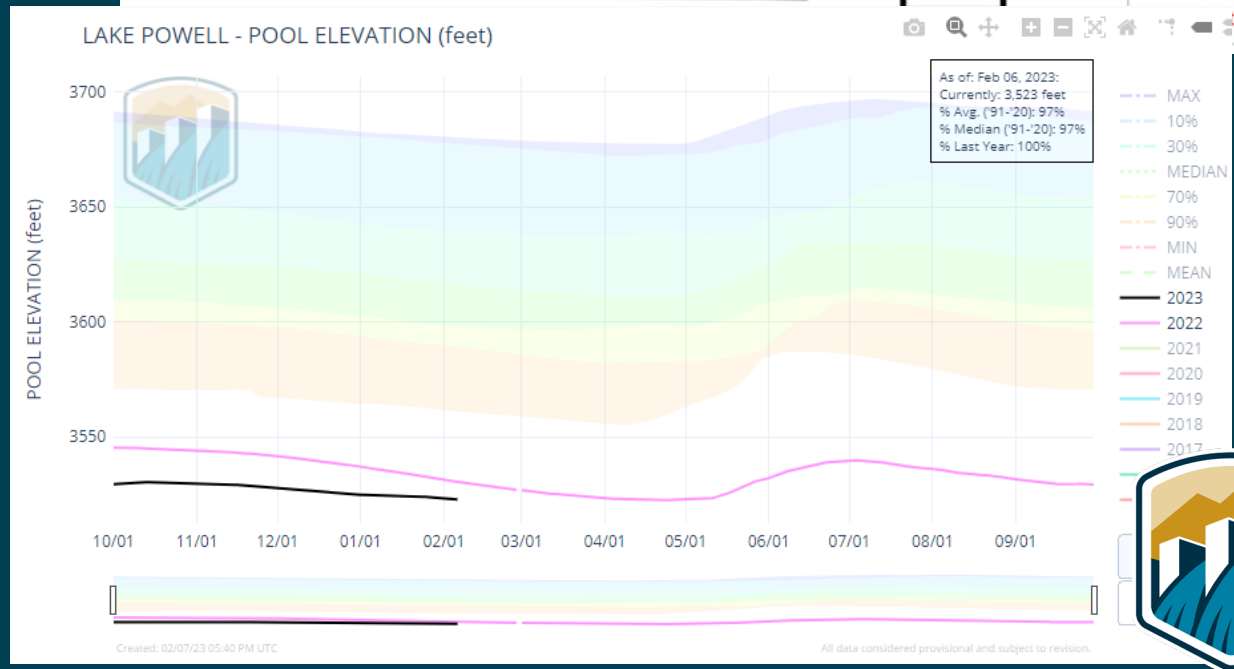
# Background: P.L. 117-43

- Extending Government Funding and Delivering Emergency Assistance Act
- Reclamation received $200 million for Addressing Drought in the West
  - Glen Canyon Bypass and Intake Generation Appraisal Studies due to drought conditions - $2 million

# Purpose and Needs

- Develop alternatives to address concerns with power generation and water releases at Glen Canyon Dam and Powerplant.
- Power revenue from Glen Canyon funds Reclamation and WAPA programs.
- Annual releases are determined by Interim Guidelines, and per the Law of the River.
- The Minimum Power Pool (MPP) is set based on the existing penstock elevations.
- Ongoing western drought is decreasing the water pool elevation, and increasing the risk of dropping below the MPP.
- The current pool elevation of Lake Powell (3522.85) is more than 177 feet below full and 32 ft above MPP.



# Alternatives

1. New intakes through Glen Canyon Dam
    a) Low-Level Power Intake with New Low Head Runners
    b) Mid-Level Power Intake with Existing Runners
2. Outlet Works Powerplant
    a) New Powerplant, 2 Units
    b) Existing Powerplant connection
3. Abutment Powerplant
    a) Left Abutment Underground Powerplant
    b) Right Abutment In-River Powerplant
4. Adjust Colorado River Basin Operations
5. Refine MPP Operating Limit
6. Invest in Solar or Wind Generation

# Alternatives discussed but not further considered

- Remove river diversion tunnel plug(s)
  - Downstream sections incorporated into spillway tunnels
  - Inlets buried in sediment (41-ft diameter tunnels)
    - Right invert (bottom) elevation – 3,137.37 feet
    - Left invert (bottom) elevation – 3,170.67 feet
  - Sediment could damage tunnel lining, penstocks, wicket gates, turbine runners
- Modify 2007 interim guidelines
  - Independent effort, already underway
- Re-operate upstream reservoirs
  - Insufficient storage capacity, only a temporary reprieve
- Low level outlet works
  - No power generation, can be incorporated into other alternatives

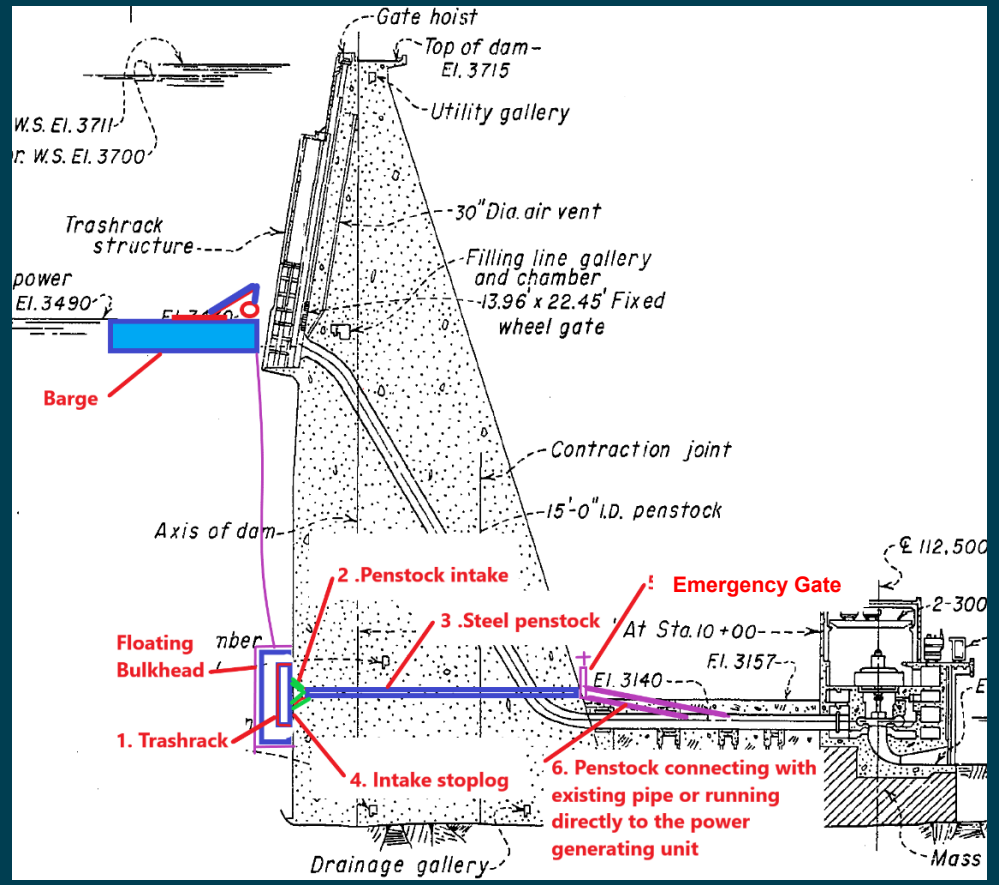
# Alternative 1a: Low-Level Power Intake - New Low Head Runners

## Description:

Penetrate through the dam, intake located in current dead pool, connect to existing penstocks downstream of the dam. Use existing power generating units with installation of new low-head runners.

## Considerations:

- New intake @ 3285 ft (or other elevation)
- Up to 185 ft additional operating range
- Requires at least 4 units
- New guard gate and trash rack required
- Increased risk from penetration through dam



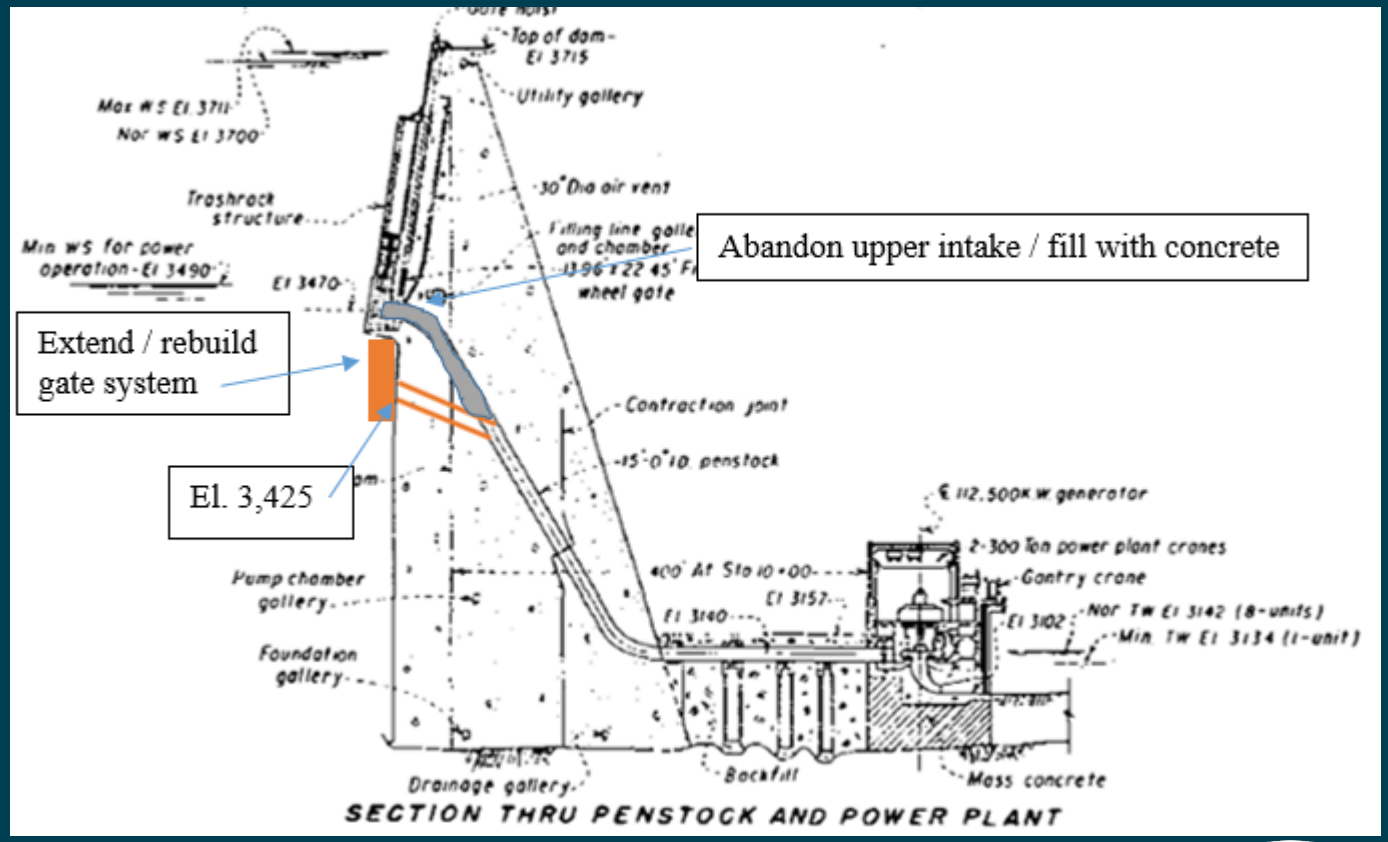
# Alternative 1b: Mid-Level Power Intake - Existing Runners

## Description:

- (4) new Mid-Level intakes
- Connects to existing penstocks
- Extended Gate/Trashrack

## Considerations:

- Uses existing turbine runners and power plant
- Operation of power plant limited to elev. 3445
- New guard gate and trash rack required
- Increased risk from penetration through dam



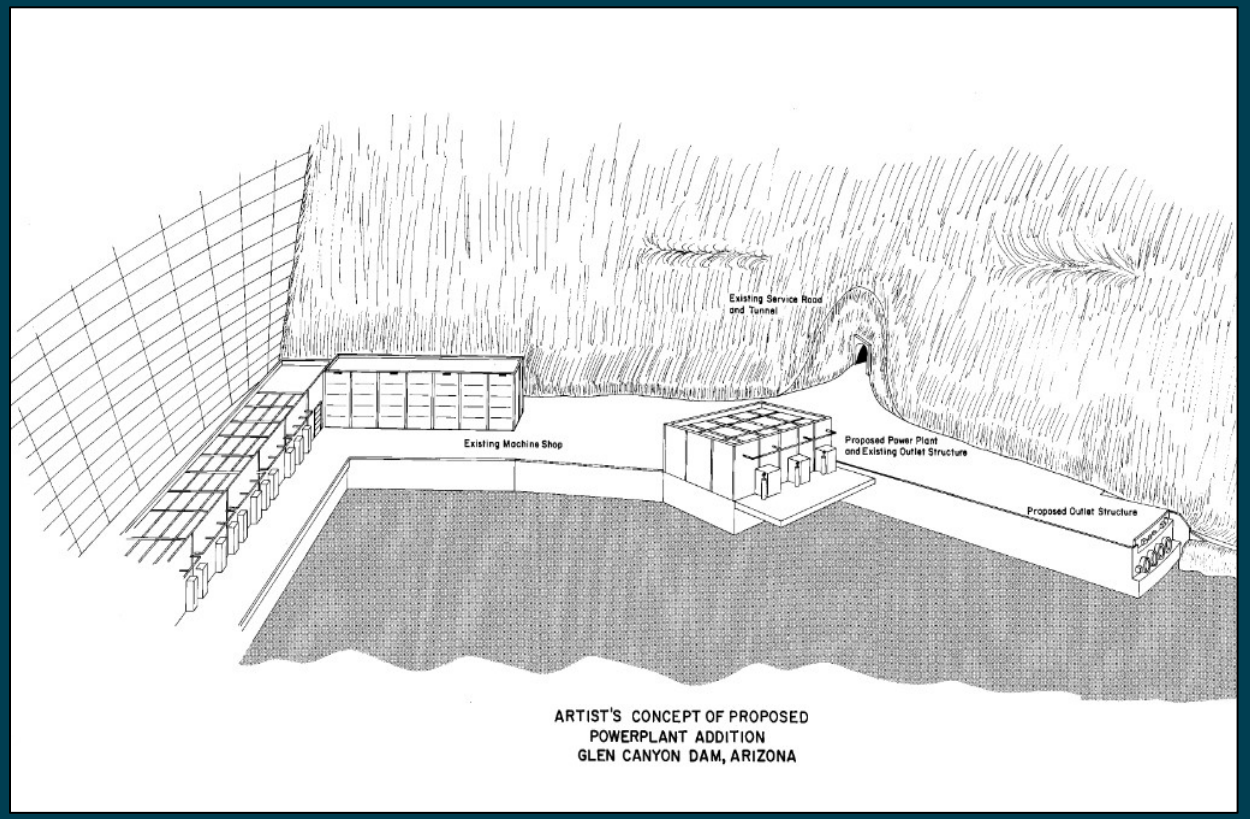
# Alternative 2a:  Bypass Powerplant (New) – Outlet Works

Description:

- Artist's rendering with PP sited at left abutment, near Machine Shop & river OW.
- Four conduits provide flow to new units with two conduits providing flow to each unit.
- Extend river OW downstream.

Considerations:

- Releases either through power plant or ROW only, not both
- High velocity = large friction loss
- Deep excavation (~100 ft) for substructure
- Low level release provides operational flexibility



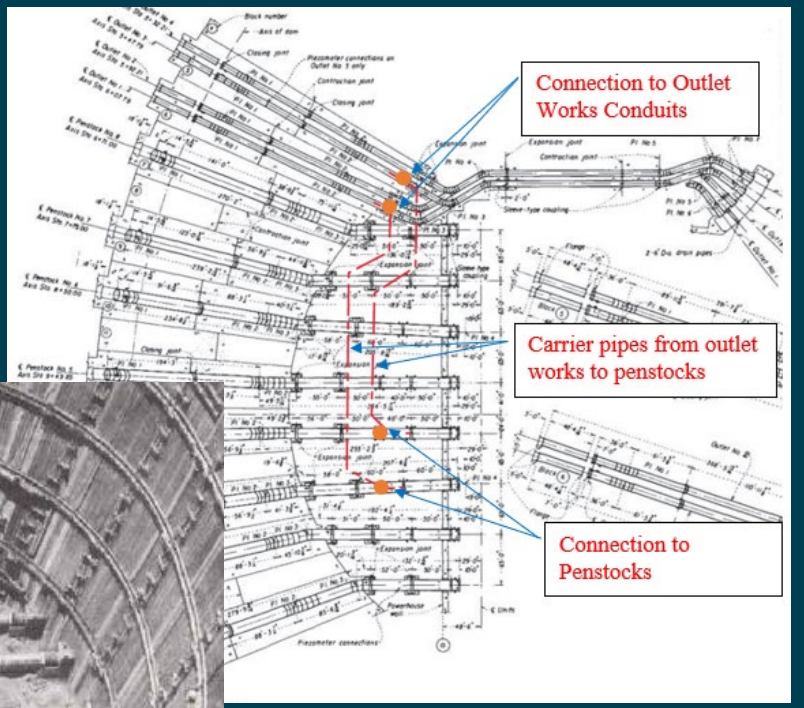
# Alternative 2b: Powerplant (Existing) – Outlet Works

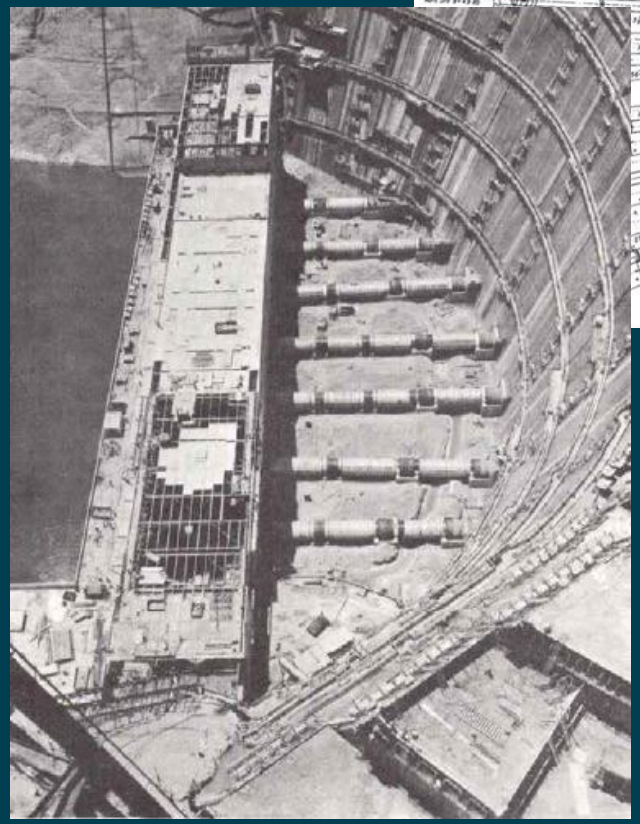
## Description:

- Use the existing infrastructure (as much as possible)
- Connect 2 of the ROW conduits to existing penstocks

## Considerations:

- Requires bypass operation in addition to power plant releases to meet 2007 IG release volumes
- High head loss requires low-head runners
- Limited space for construction



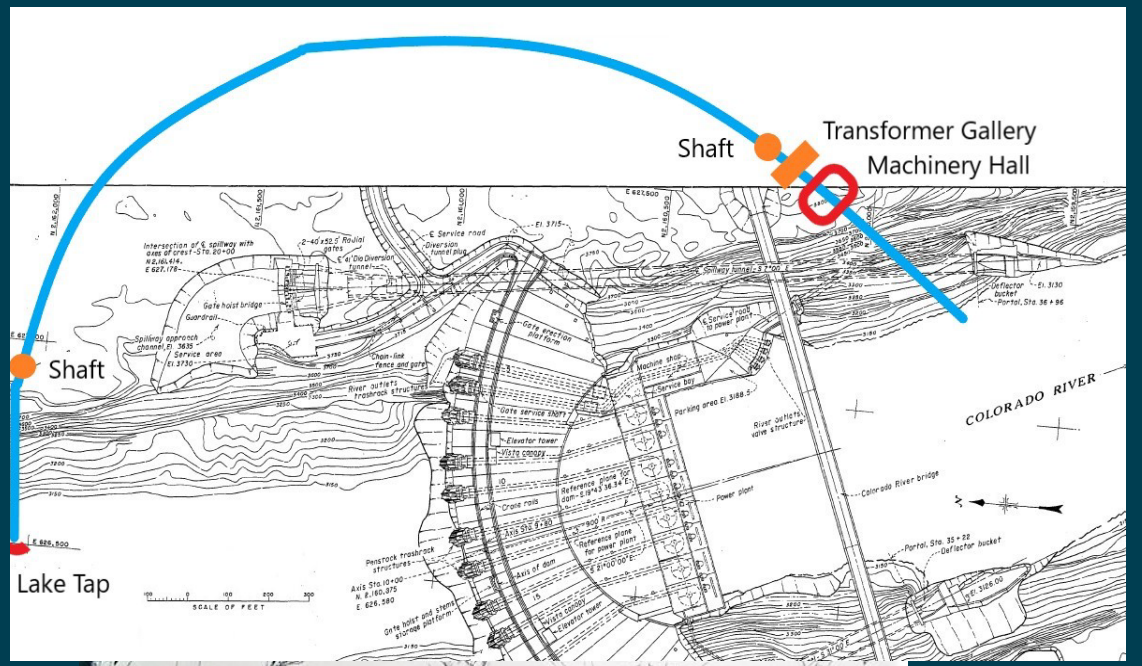
# Alternative 3a: Left Abutment Underground Powerplant

Description:

- Tunnel through left abutment
- Underground power plant

Considerations:

- Penstock and power plant size can be designed to maximize water/power
- Rock mechanics, seepage control, construction underground, maintenance, cost
- Low level release provides operational flexibility
- Increased capacity for HFEs



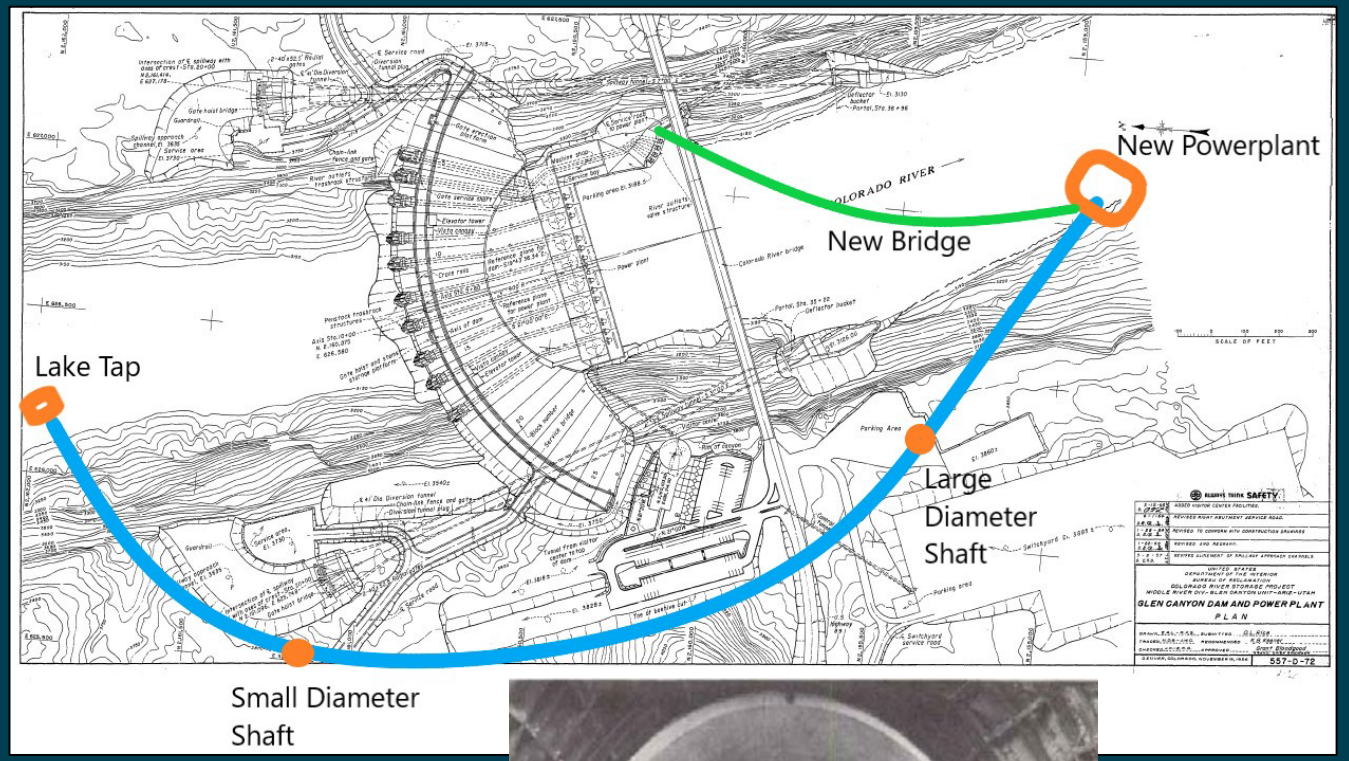

# Alternative 3b:  Right Abutment Powerplant

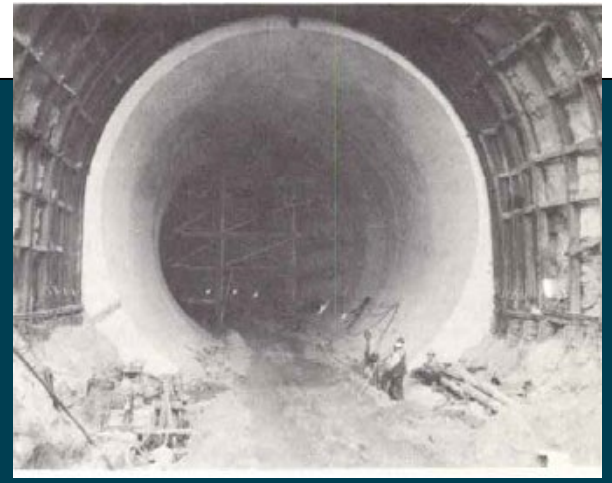
Description:

- Tunnel through right abutment
- Power plant in river bed

Considerations

- Penstock and power plant size can be designed to maximize water/power
- Rock mechanics, construction in river, maintenance, cost
- Low level release provides operational flexibility
- Increased capacity for HFEs



# Alternative 4: Adjust Colorado Basin Operations

## Description:

Adjust operations on a system-wide basis (Glen Canyon and Hoover) to maximize power generation under low flow conditions using existing infrastructure.

## Considerations

- Potentially addressed by ongoing SEIS and post-2026 guidelines efforts
- Lower infrastructure investment
- Does not address lost revenue if no generation below MPP

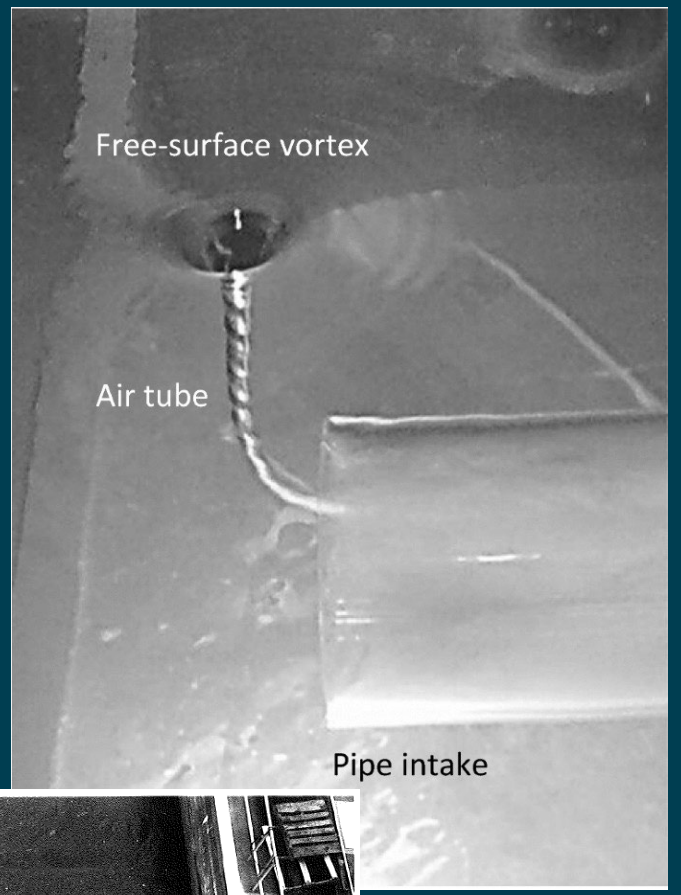
# Alternative 5:  Refine MPP Operating Limit

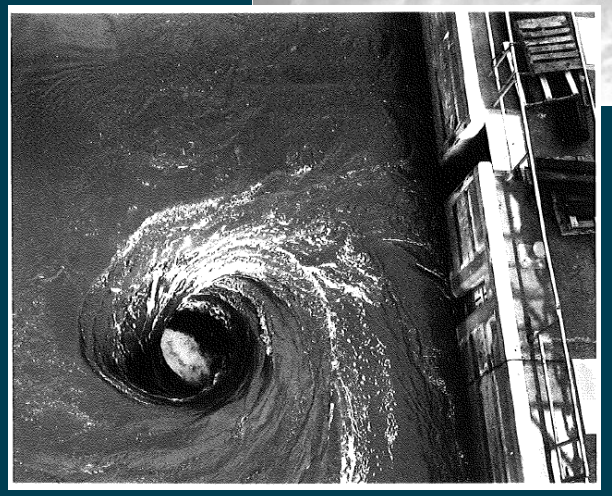
## Description:

- MPP probably due to vortex formation as intake submergence is reduced
- Modeling to simulate flows at reservoir levels approaching and below the MPP
- Potential addition of vortex-suppressing structures

## Considerations:

- Limited operational benefit, not greater than elev. 3477.5
- No structural modifications
- Modeling efforts are underway
- Low cost



# Alternative 6:  Invest in Solar or Wind Generation

## Description:

- Invest in other renewable energy sources to augment hydro power resources

## Considerations:

- Scalable
- Requires large land areas
- Authority – CRSP only authorizes hydropower
- Expertise – this is not Reclamation's expertise
- Can be developed independent of Reclamation
  - Customers exploring options

# Power Generation and Flow

**Operations At or Below Reservoir Elevation of 3,490 ft (MPP)**

| | | Operating Range (Min Elevation) | | | Operating Range (Max Elevation) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Alternative | Intake elevation (ft) | Elevation (ft) | Total Max flow (cfs) | Approx. Total Max Power Output (MW) | Elevation (ft) | Total Max flow (cfs) | Approx. Total Max Power Output (MW) | Number of Units | Outlet works can be used to supplement flow as needed |
| 1a (Low-level intake, low-head runner) | 3,285 | 3,390 | 8,400 | 135 | 3,490 | 10,800 | 240 | 4 | Yes, to 3390 |
| 1b (Mid-level intake) | 3,425 | 3,445 | 10,000 | 210 | 3,490 | 12,000 | 310 | 4 | Yes |
| 2a (Powerplant at outlet works) | 3,390 | 3,390 | 4,000 | 65 | 3,490 | 15,000 | 340 | 2 | No |
| 2b (Low Head Runner) | 3,374 | 3,390 | 2,000 | 60 | 3,490 | 7,500 | 170 | 2 | Yes |
| 3a (Left Abutment Powerplant) | 3,370 | 3,390 | 9,200 | 160 | 3,490 | 14,000 | 350 | 2 | Yes |
| 3b (Right Abutment Powerplant) | 3,370 | 3,390 | 9,200 | 160 | 3,490 | 14,000 | 350 | 2 | Yes |
| 4 (Adjust Colorado River Basin Operations) | | | | | | | | 0 | Yes |
| 5 (Refine MPP Operations) | | | | | | | | 0 | Yes |
| 6 (Invest in Solar and Wind) | | | | | | | 200 | 0 | Yes |

# GCD Maximum Flows

| Alternative | Maximum flow, >3,490 | Maximum flow, <3,490 | Power Plant flow, >3,490 | Power Plant flow, <3,490 |
|---|---|---|---|---|
| Current | ~45,000 cfs | 15,000 cfs | ~30,000 cfs | 0 cfs |
| Alt. 1a (low level intake) | ~45,000 cfs | 27,000 cfs | ~30,000 cfs | 12,000 cfs |
| Alt 1b (mid-level intake) | ~45,000 cfs | 27,000 cfs | ~30,000 cfs | 12,000 cfs |
| Alt 2a (bypass power plant) | ~45,000 cfs | 15,000 cfs | ~45,000 cfs | 15,000 cfs |
| Alt 2b (ROW to existing PP) | ~45,000 cfs | 15,000 cfs | ~30,000 cfs | 7,500 cfs |
| Alt 3a & b (abutment PPs) | ~59,000 cfs | 29,000 cfs | ~44,000 cfs | 14,000 cfs |

# Non-power generation considerations

| Alternative | Power intake elevation | Augment normal release w/colder water | Increased maximum discharge | Flexibility for water quality (dissolved oxygen or other) |
|---|---|---|---|---|
| Current | 3,470 | No | No | No |
| Alt. 1a (low level intake) | 3,285 (or per design) | Yes | No | Yes |
| Alt 1b (mid-level intake) | 3,425 | Yes | No | Yes |
| Alt 2a (bypass power plant) | 3,374 | Yes | No (>powerplant max discharge) | Yes |
| Alt 2b (ROW to existing PP) | 3,374 | Yes | No (>powerplant max discharge) | Yes |
| Alt 3a & b (abutment PPs) | 3,370 (or per design) | Yes | Yes | Yes |

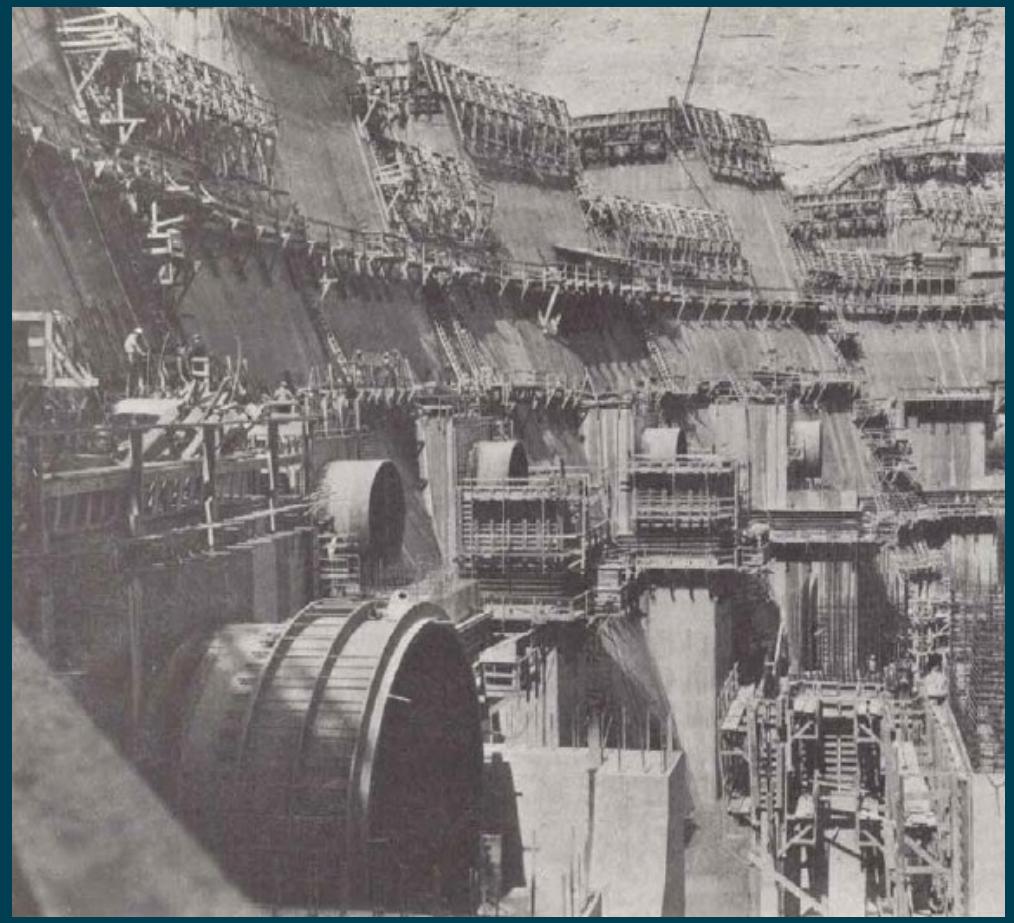
# Other considerations

- Authority
- Costs: capital, life cycle and O&M
- Construction time-line
- Repayment
- Environmental opportunities & impacts
  - Temperature
  - Capacity for HFEs
  - Dissolved oxygen & other water quality considerations

# Next Steps

## Where do we go from here?

- Partner and stakeholder briefings
- Select alternative(s) (spring 2023)
- Appraisal Study (Reclamation TSC)
  - Schedule:  2023-2024
  - $2M from 2022 CR drought funding
  - Stakeholder participation and input



# Next Steps

Authority and funding would be required to proceed beyond appraisal

- Planning continued…
  - Feasibility Study
  - NEPA
- Design
- Construction
- Operation

# QUESTIONS?

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